Tuesday, November 21, 2017 10:19 AM

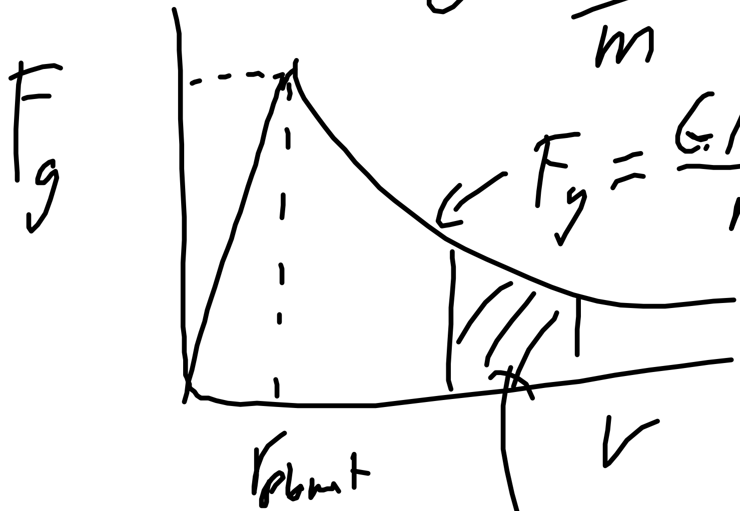
Gravitational Energy
- Energy of orbital motion
- Energy of interplanetary projectiles

field strength

$$g = \frac{F_g}{m} = \frac{GM}{r^2}$$

Recall:

`



$$F_g = \frac{GMm}{r^2}$$

area $= W_g = \Delta E_g$

$$\int F_g\,dr = \int \frac{GMm}{r^2}\,dr = -GMm\left(\frac{1}{r_f} - \frac{1}{r_i}\right)$$

$$\frac{1}{3} - \frac{1}{2} \neq 1$$

$$\boxed{E_g = -\frac{GMm}{r}}$$

relative to $E_g \to 0$ as $r \to \infty$

Work done moving mass m from ∞ to r

Graph of E_g, E_k and E_T

i) mass m in orbit radius r around mass M.

ii) mass m moving at velocity v away from mass M

a) at escape speed

b) $v < v_{escape}$

c) $v > v_{escape}$

- derive an equation for

$F_g = F_c$ → E_k in terms of r, M, m for orbit

- derive escape speed equation

$$\left|\frac{GM\cancel{m}}{r}\right| = \frac{1}{2}\cancel{m}v^2$$

$$v_{escape} = \sqrt{\frac{2GM}{r}}$$

Don't confuse with V=-GM/r
V is gravitational potential defined as the gravitational energy per unit mass.

or, don't confuse with orbital speed

$$F_g = F_c$$

$$\frac{GM\cancel{m}}{r^{\cancel{2}}} = \frac{\cancel{m}v^2}{\cancel{r}}$$

$$v_{orbit} = \sqrt{\frac{GM}{r}}$$

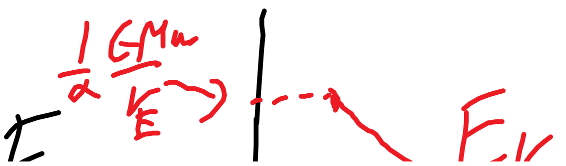
orbital Kinetic Energy

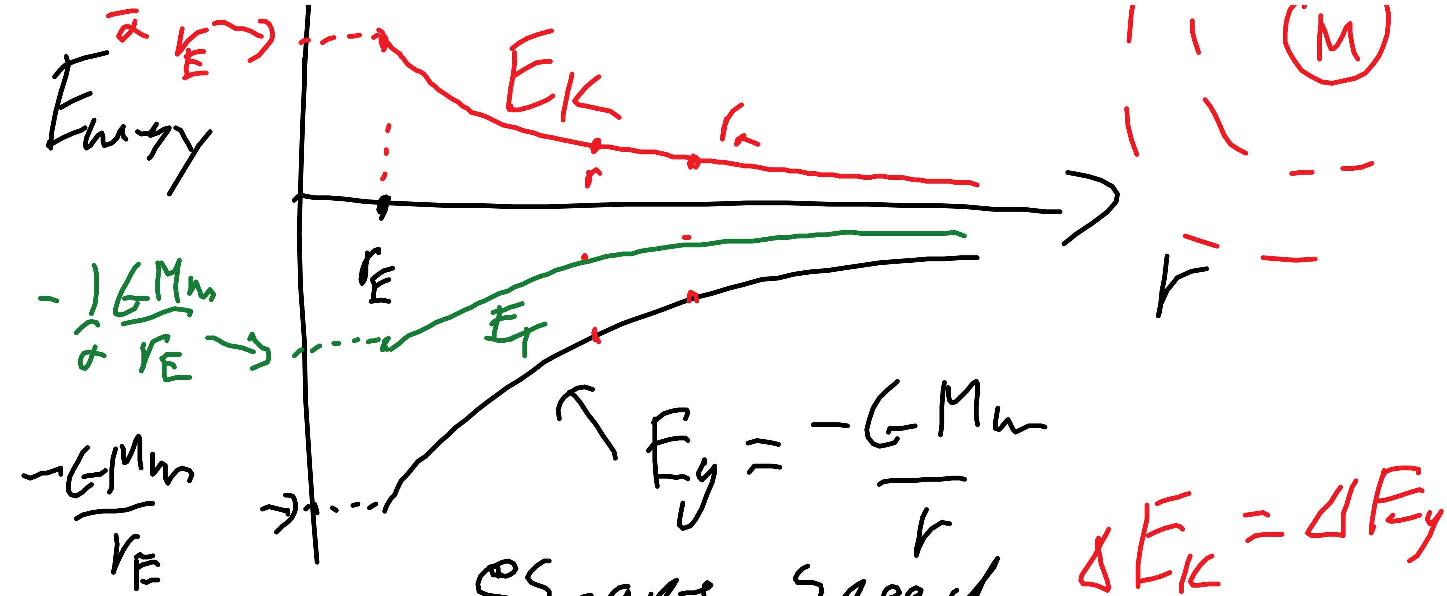
$$E_K = \frac{1}{2}mv^2 = \frac{1}{2}\frac{GMm}{r} \to |E_g|$$

* orbital Kinetic Energy $= \frac{1}{2}|E_g|$

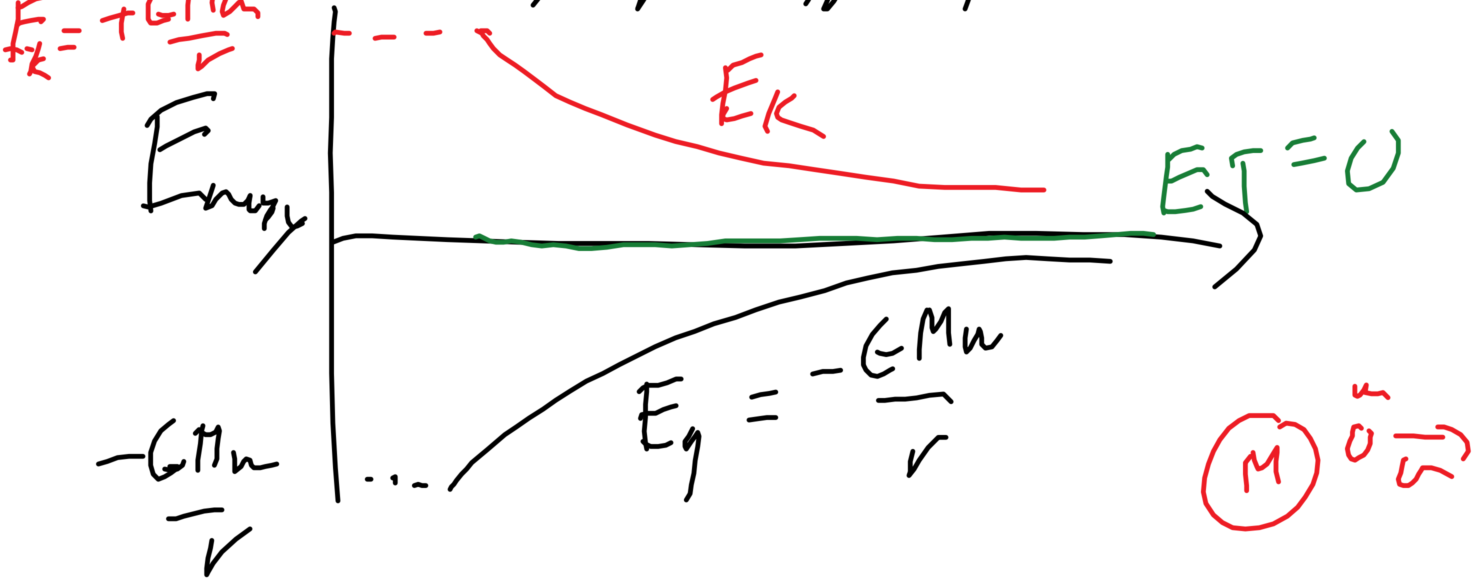
$$E_{Total} = E_K + E_g = \frac{1}{2}E_g$$

orbital Energy Graphs

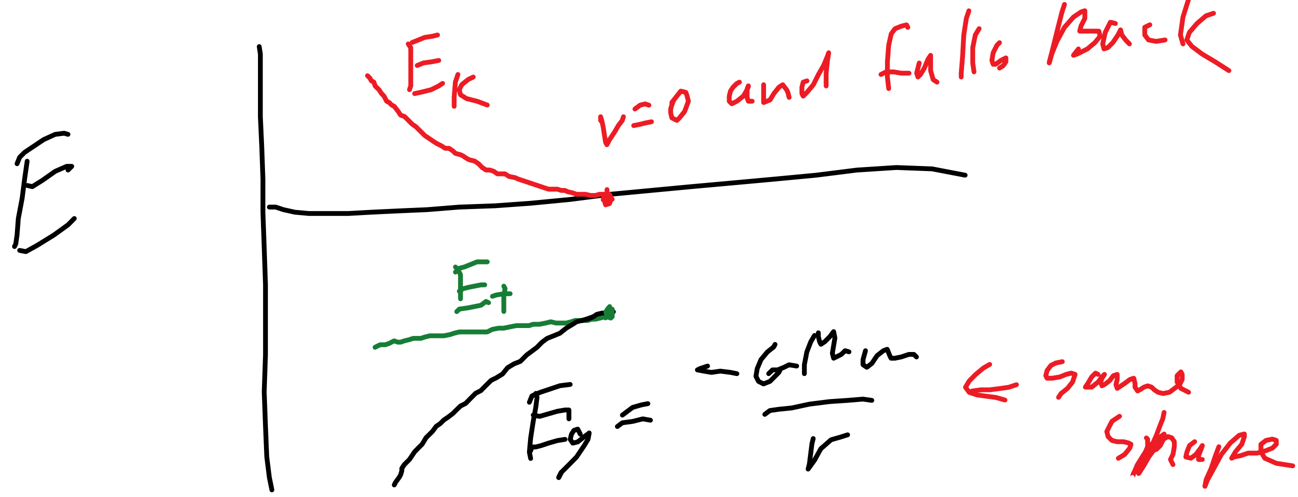




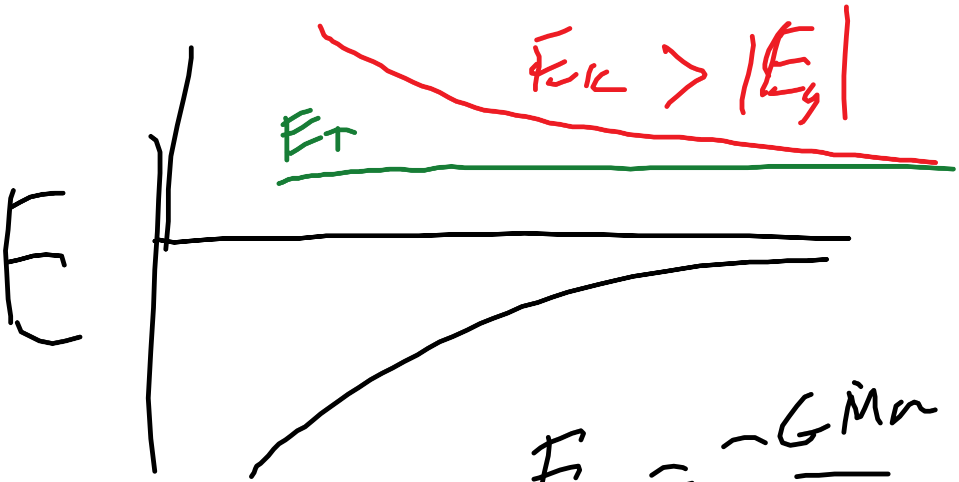
escape speed



$V < V_{escape}$



$v > v_{escape}$



$$E_g = -\frac{GMm}{r}$$